Toward Volatile Metal Complexes of Rutherfordium. I. Synthesis of β-diketonates of Hafnium and Zirconium

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The chemical investigation of the transactinide elements (TAN, Z ≥ 104) is a topic of great interest in recent nuclear chemistry research. In gas phase experiments, mostly volatile inorganic compounds (e.g., halides or oxides) of TAN were investigated. More sophisticated chemical studies have not yet been possible due to, e.g., low production cross-sections or short half-lives and also technical challenges. One restriction in present TAN research is the plasma behind the target caused by the intense heavy ion beam. "Weak" molecules (e.g., organic ligands) are immediately destroyed, thus limiting the possibilities of synthesizing chemical compounds directly behind the target to "simple" and robust inorganic compounds. It is highly desirable to expand the knowledge on the chemical behavior of the TAN to other compound classes, e.g., volatile metal complexes. The use of the Berkeley Gas-filled Separator (BGS) as a physical preseparator makes such studies possible by separating the beam from the desired TAN isotopes.

A compound class that appears suitable for such studies are the β-diketonates. Hexafluoroacetylacetone (hfa) complexes of group 4 elements are known to be fairly stable and highly volatile [1]. This chemical system was therefore chosen for first studies. The experimental setup is depicted in Figure 1.

^{169}Hf ($T_{½}$=3.24 min) and ^{85}Zr ($T_{½}$=7.86 min) were produced in the reactions ^{124}Sn(^{50}Ti, 5n)^{169}Hf and ^{nat}Ge(^{18}O,xn)^{85}Zr. The isotopes were preseparated in the BGS before entering the Recoil Transfer Chamber (RTC) [2] where they were thermalized in a He-hfa atmosphere. The gas flow (1.3 L/min) transported the isotopes to a nearby oven (250°C) where formation of the volatile metal complexes took place. The yield of this step was measured to be 95% for the Hf complexes. These were transported through a 5 m long PFA Teflon capillary to an on-line thermochromatography (TC) setup. The transport yield was 95%. Results of first TC experiments are described in a separate contribution to this annual report [3].

REFERENCES

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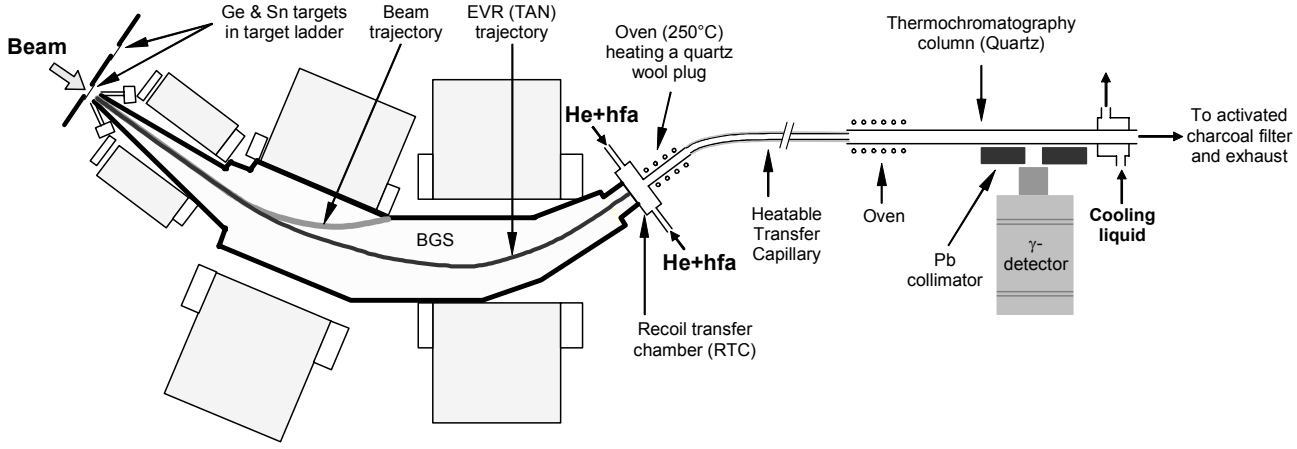

FIGURE 1: Schematic of the experimental setup used in these studies.